Scents and Sensibility:

Dimensionality Reduction on Neural and Behavioral Responses to Aromas

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Introduction

Many of the effects of aromas on behavior are thought to be driven by the pleasantness of aromas. The majority of analyses investigating these effects are univariate and model-driven. The current study employs multivariate, model-free methods to determine:

1) **Sub-dimensions of aroma pleasantness.** Do these dimensions activate neural regions relevant to decision-making?

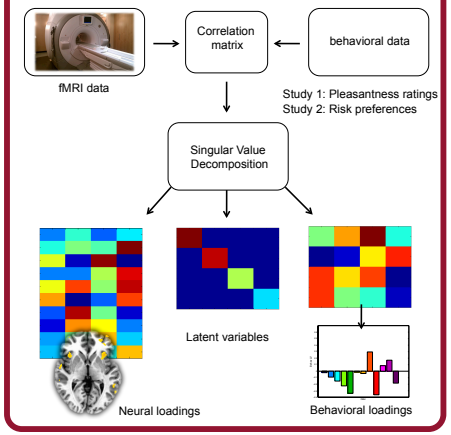
2) **Mechanisms behind the influence of aroma pleasantness on risk-taking behavior**.

E.g. both roast turkey and lavender might smell "pleasant" – but not for the same reason. Do both influence behavior equivalently?

Partial Least Squares

Partial Least Squares (PLS) Regression

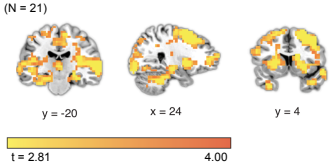
PLS analysis was performed to identify latent variables in the covariance between behavioral measures and fMRI activity[1].

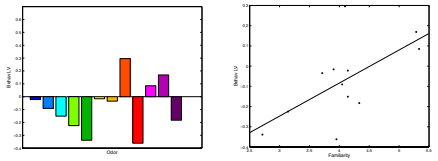


Results

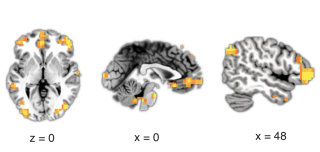
Study 1: Dimensions of aroma pleasantness

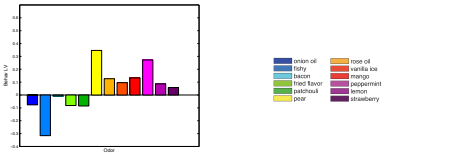
(N = 21)





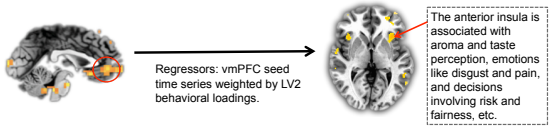
LV1: LV1 loadings correlated with familiarity ratings (r = -0.618, P = 0.0324) . Widespread regions contribute to the first LV, including the hippocampus (memory), dorsal striatum (reward learning), and regions throughout the middle frontal gyrus (higher cognitive processes).





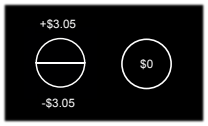
LV2: LV2 loadings correlated with pleasantness (r = 0.705, P = 0.0105) . Brain areas associated with this LV included medial and lateral OFC (pleasant/unpleasantness), and regions of the vmPFC (decision-making).

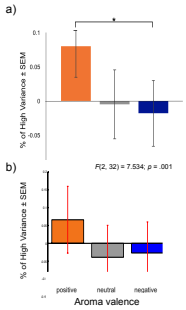
Connectivity analysis: The vmPFC is thought to integrate signals from other brain regions to guide decisions[2]. Activity in the insula and mOFC were found to be correlated with vmPFC activity.



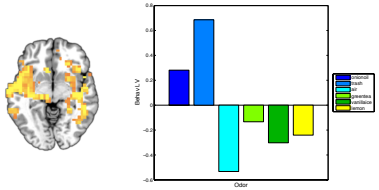
Study 2: Effects of aroma pleasantness on risk-taking

(N = 11)





In an earlier behavioral study **(a)**, risk preference was found to be higher in trials with pleasant aromas vs unpleasant aromas. This trend also appeared in the fMRI study **(b)**.



One significant LV was found. A large portion of the insula contributed to this dimension. Unpleasant aromas loaded on this dimension in an opposite direction from neutral and pleasant aromas.

Conclusions

Study 1: Sub-dimensions of pleasantness activate unique sets of brain regions

- Four significant dimensions were found in study 1, each associated with unique patterns of neural activity.
- Familiarity was the primary driver of pleasantness in study 1's dataset. This might be related to the mere exposure effect.
- The second LV was associated with the OFC and vmPFC, and correlated with subjective pleasantness. The vmPFC might integrate diverse signals from areas such as the insula and mOFC to produce an overall value signal.

Study 2: The insula is involved in the effects of aroma pleasantness on risk-taking

- The insula is associated with loss aversion[3]. Lower risk preference observed with unpleasant aromas might be due to higher risk aversion, reflected in insula activity.

Overall, model-free analyses complement model-driven analyses of fMRI data, and expose patterns not predicted by model-driven analyses.

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